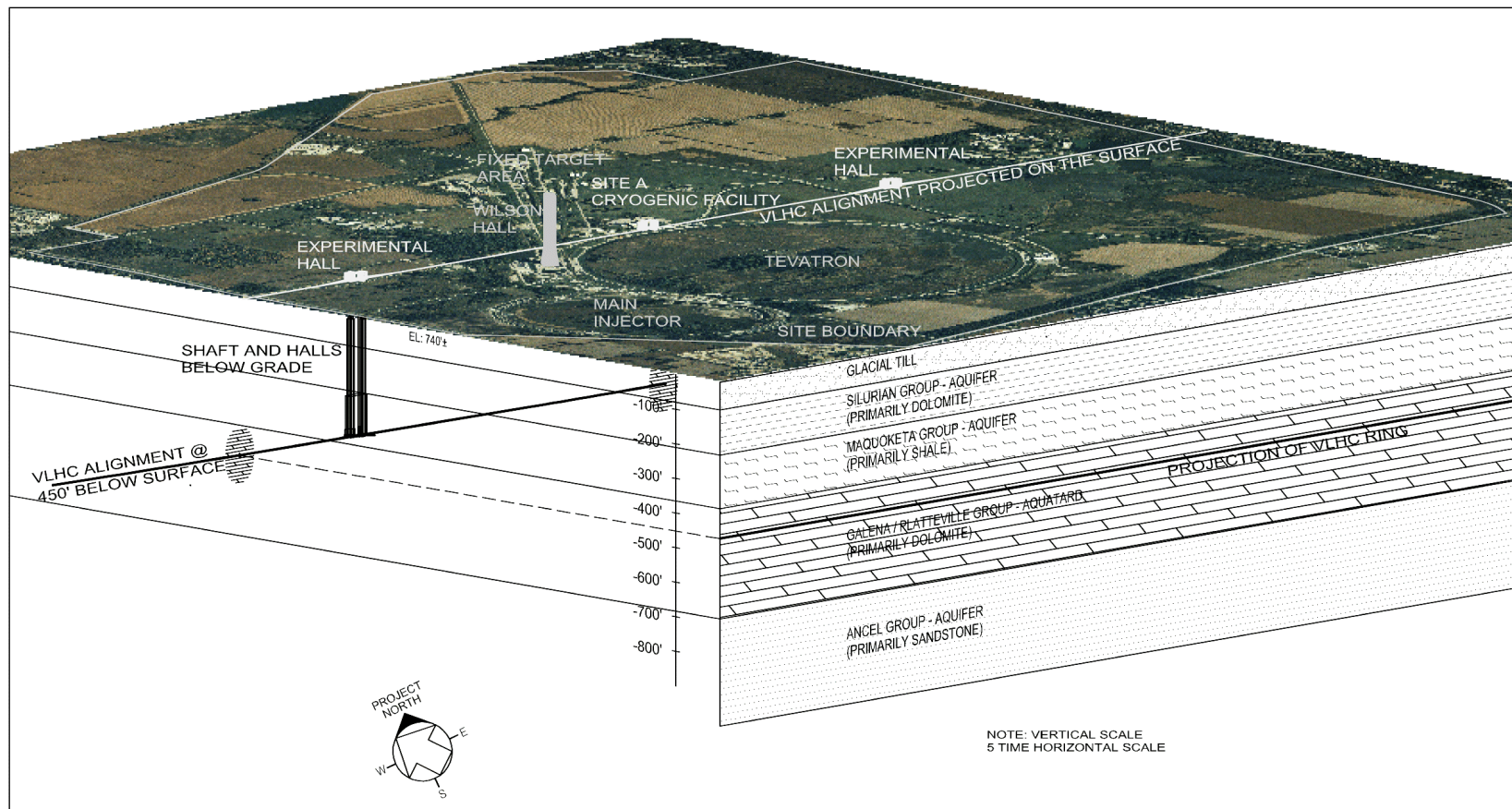


VLHC Conventional Construction

Peter H. Garbincius

HEPAP Subpanel on Long Range Planning

June 11, 2001



Agenda

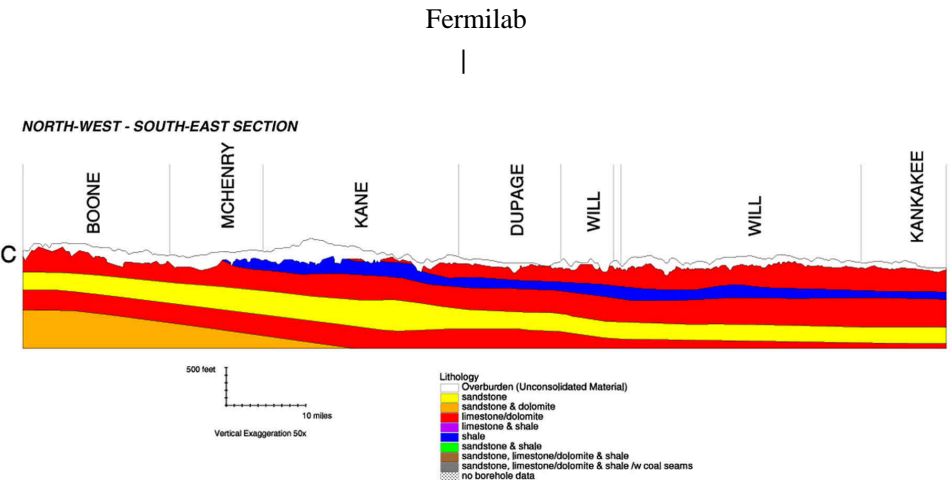
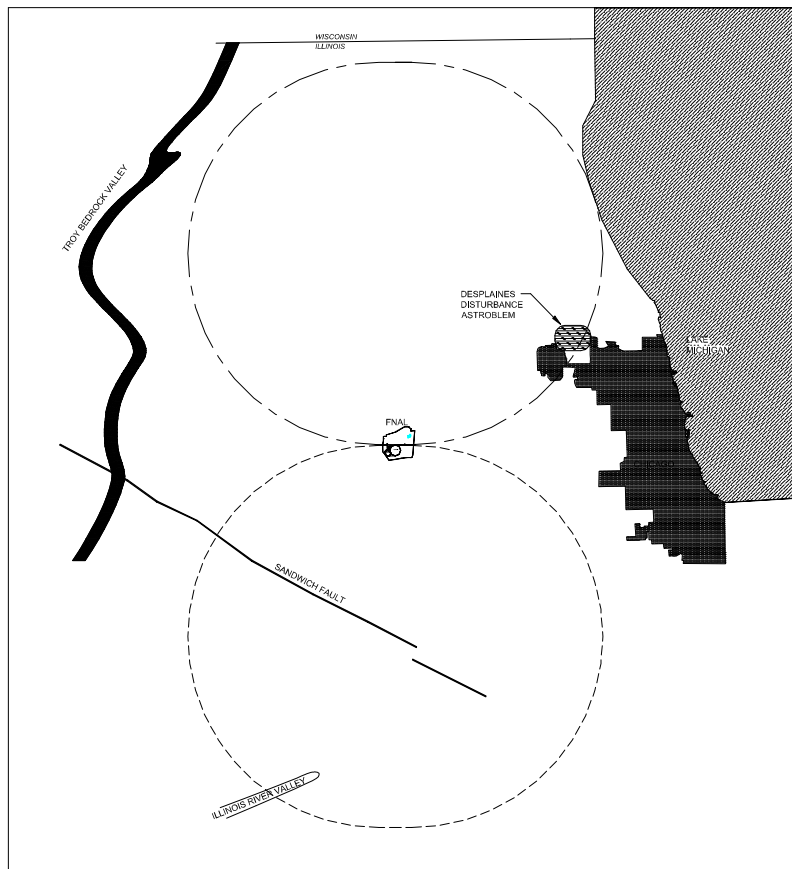
- **Geologic Considerations & Siting Studies**
- **Tunnel, Beam Lines, Enclosures, Facilities and Experimental Areas**
- **CNA Cost & Schedule Estimating Exercise**
- **Preliminary Model of Schedule**
- **Cost Estimate**
- **ES&H Issues Specific to VLHC**
- **Design and Cost Challenges**

These are NOT siting proposals

- These are three models to study cost sensitivity of underground construction to various geologic conditions.

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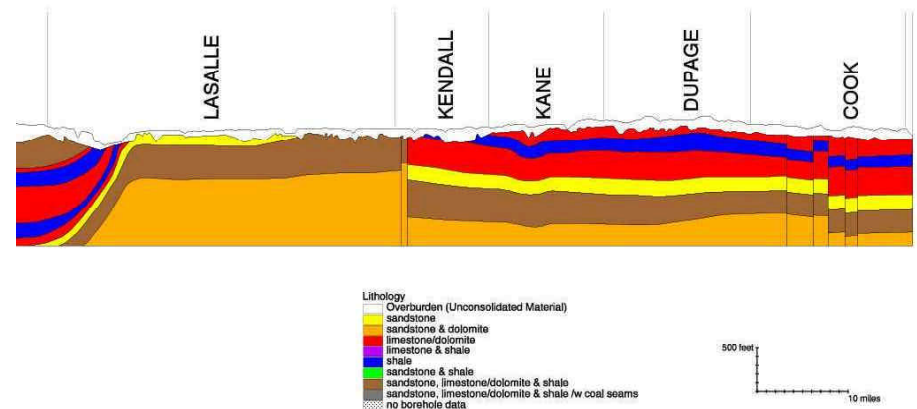


Southwest-to-Northeast

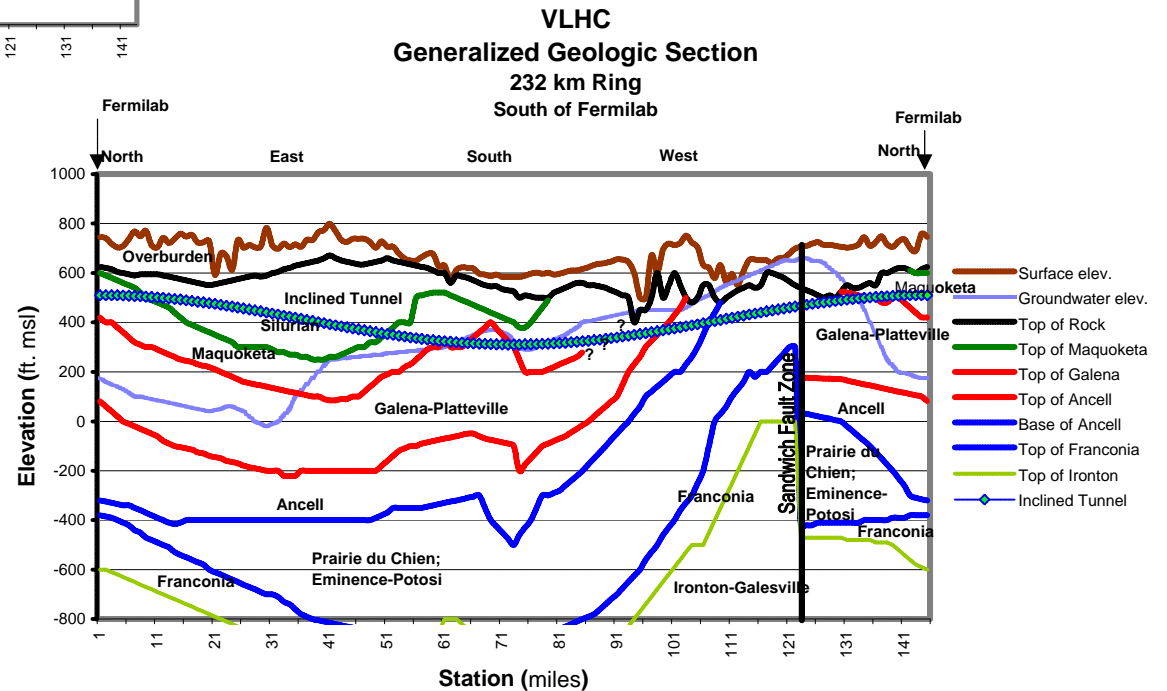
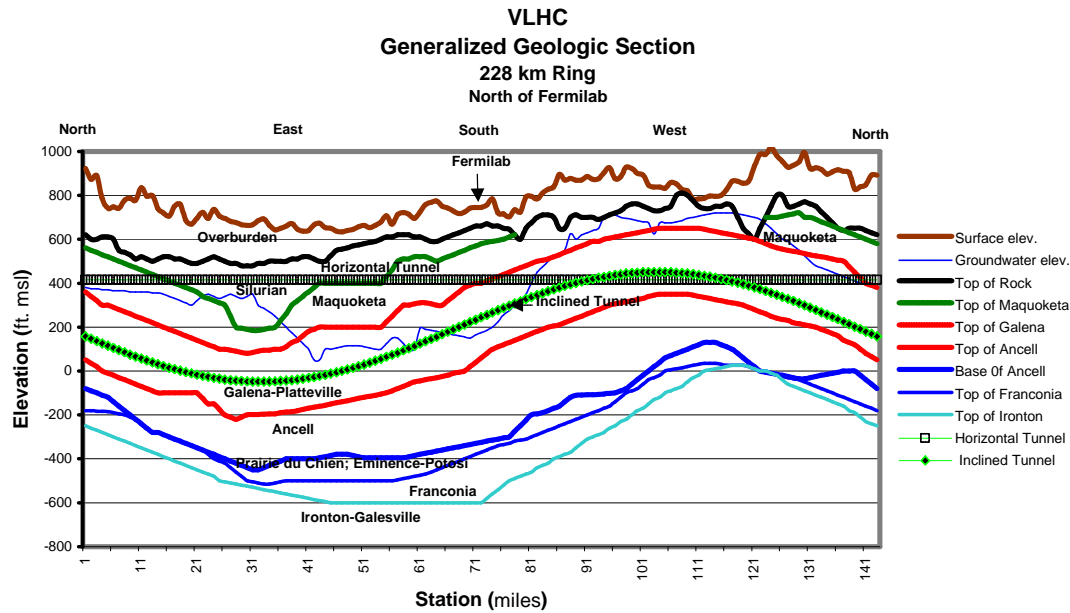
Sandwich
Fault

Fermilab

DesPlaines
disturbance

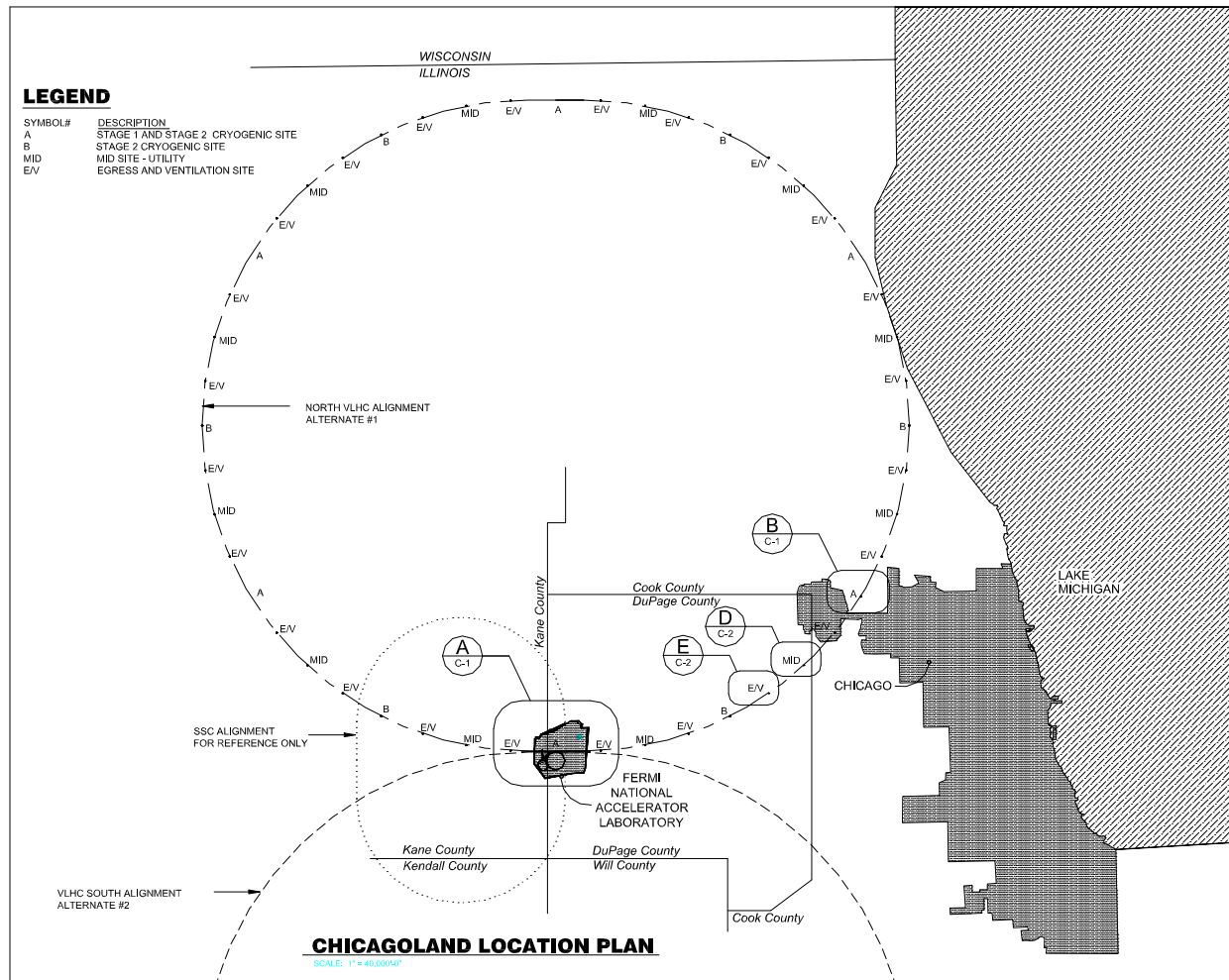


Lampshades - ring elevations & strata

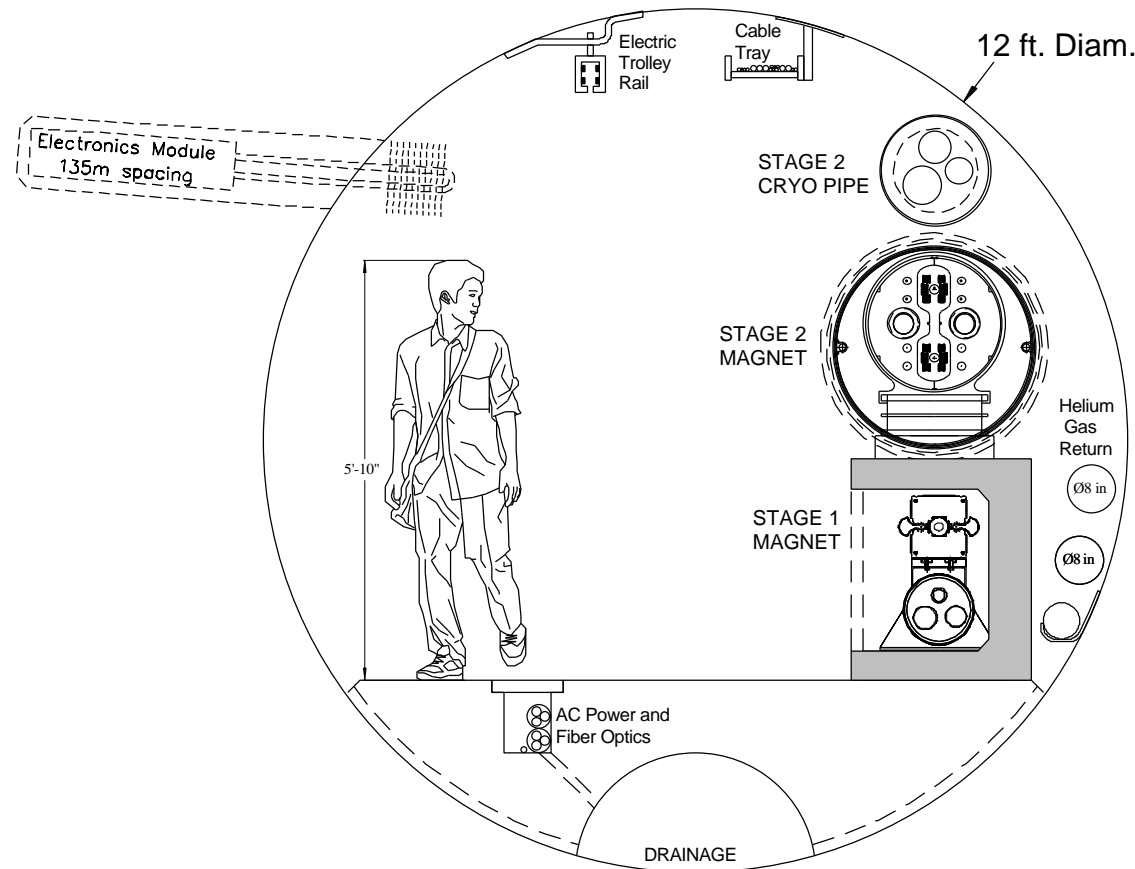


Off-site Service Areas

- Again, these are NOT siting proposals

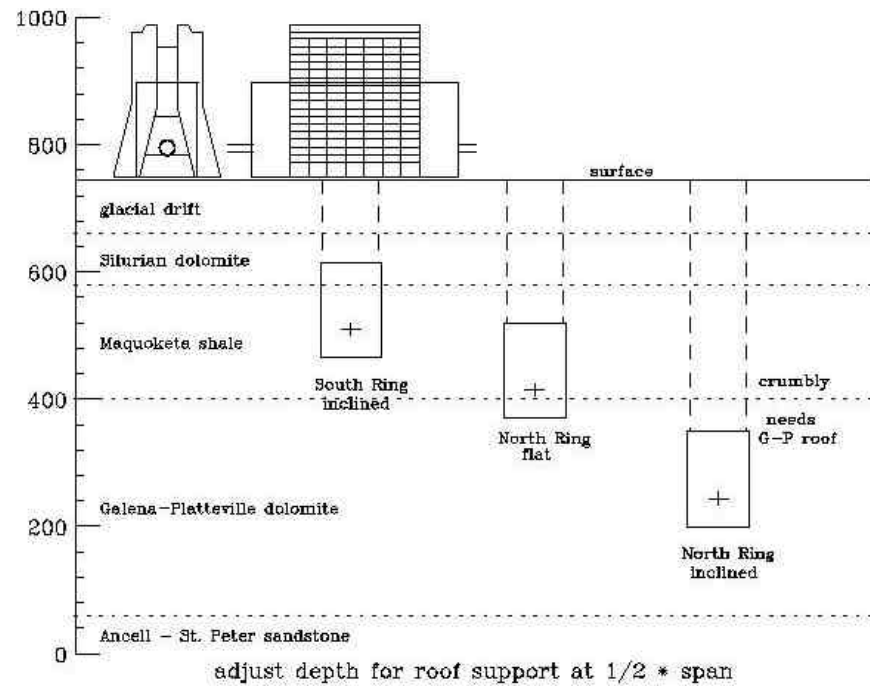
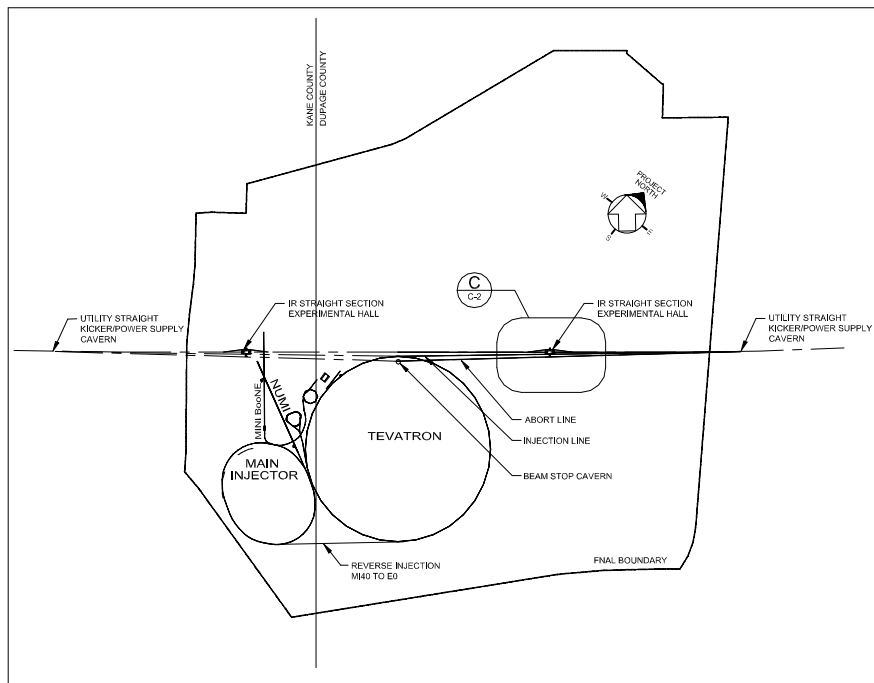


Cross section of 12 ft. finished dia. tunnel

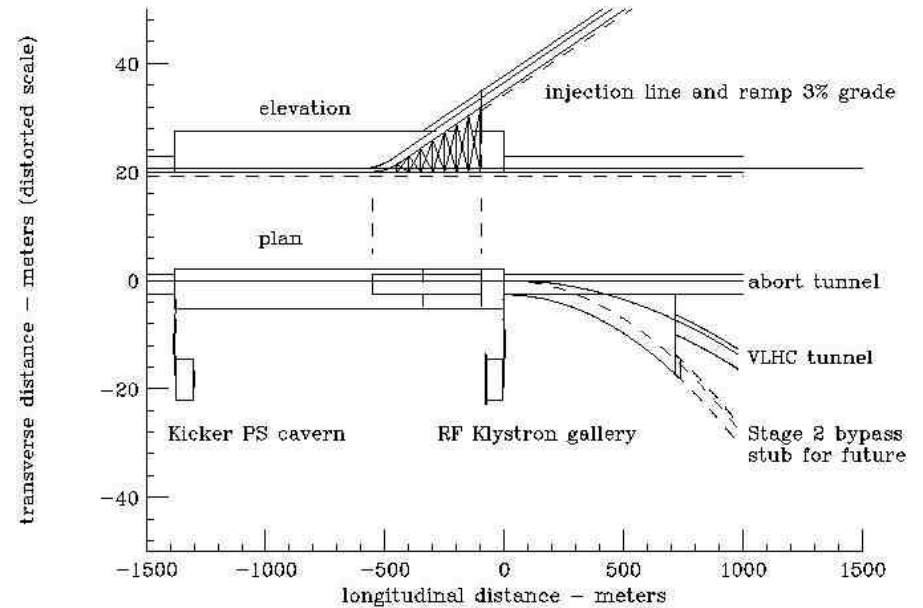
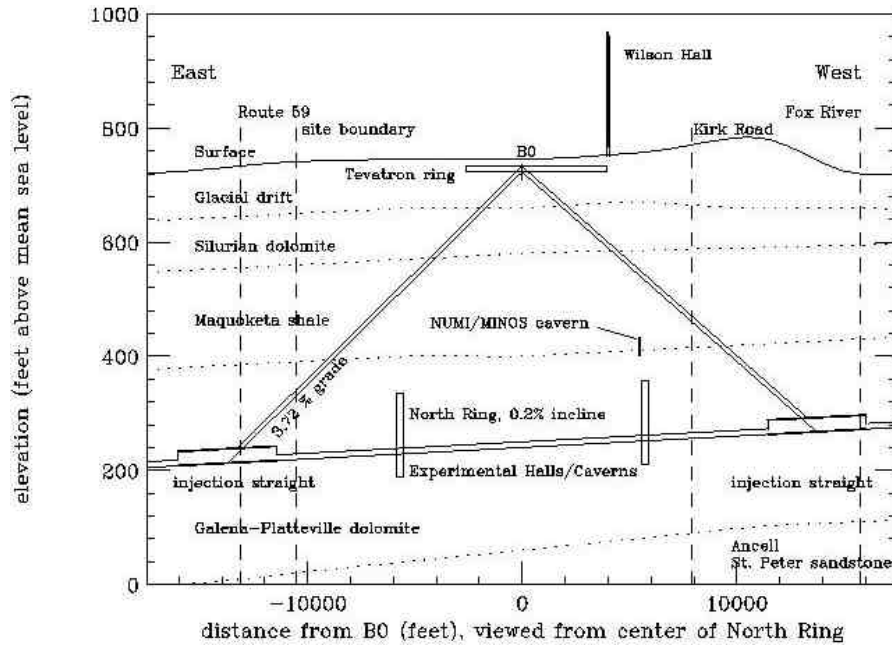


- also cost estimated a 16 ft. finished dia. tunnel
- specify < 50 gpm/mile avg. water inflow rate

Fermilab Footprint and Experimental Halls

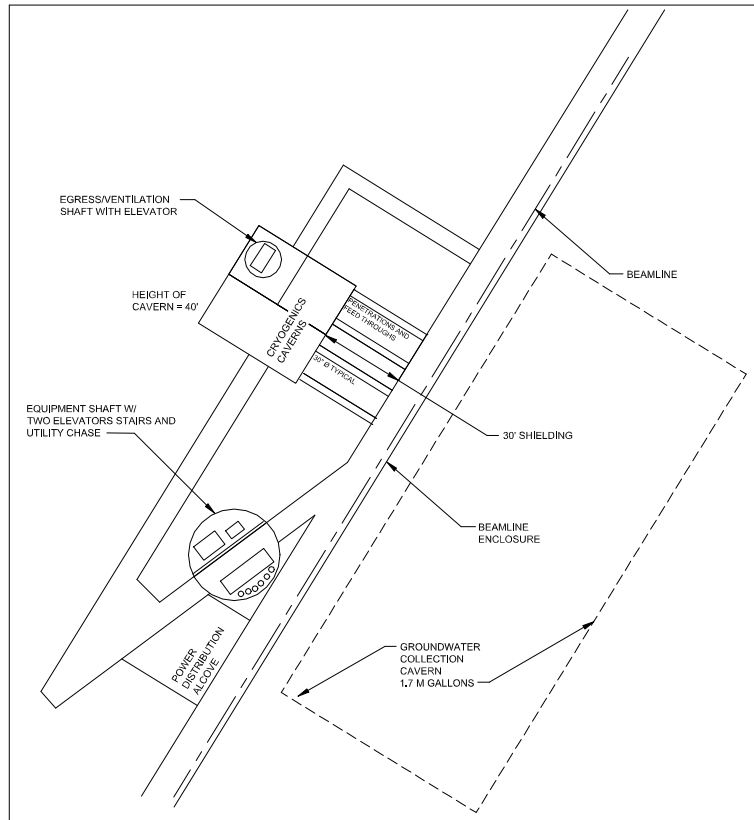


Injection Ramps & Caverns

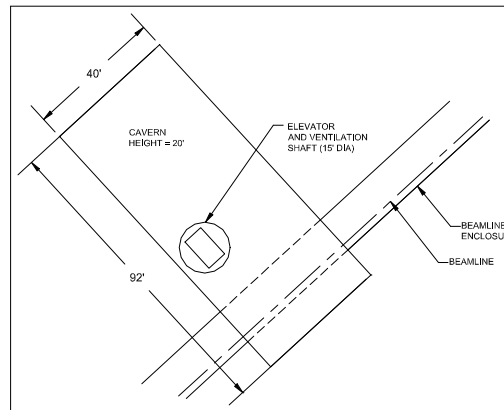


Underground Enclosures

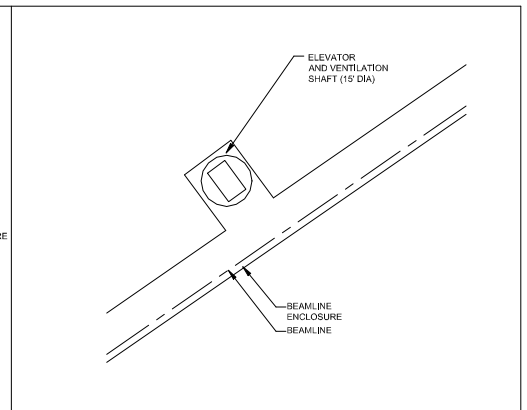
A/B sites



mid-sites



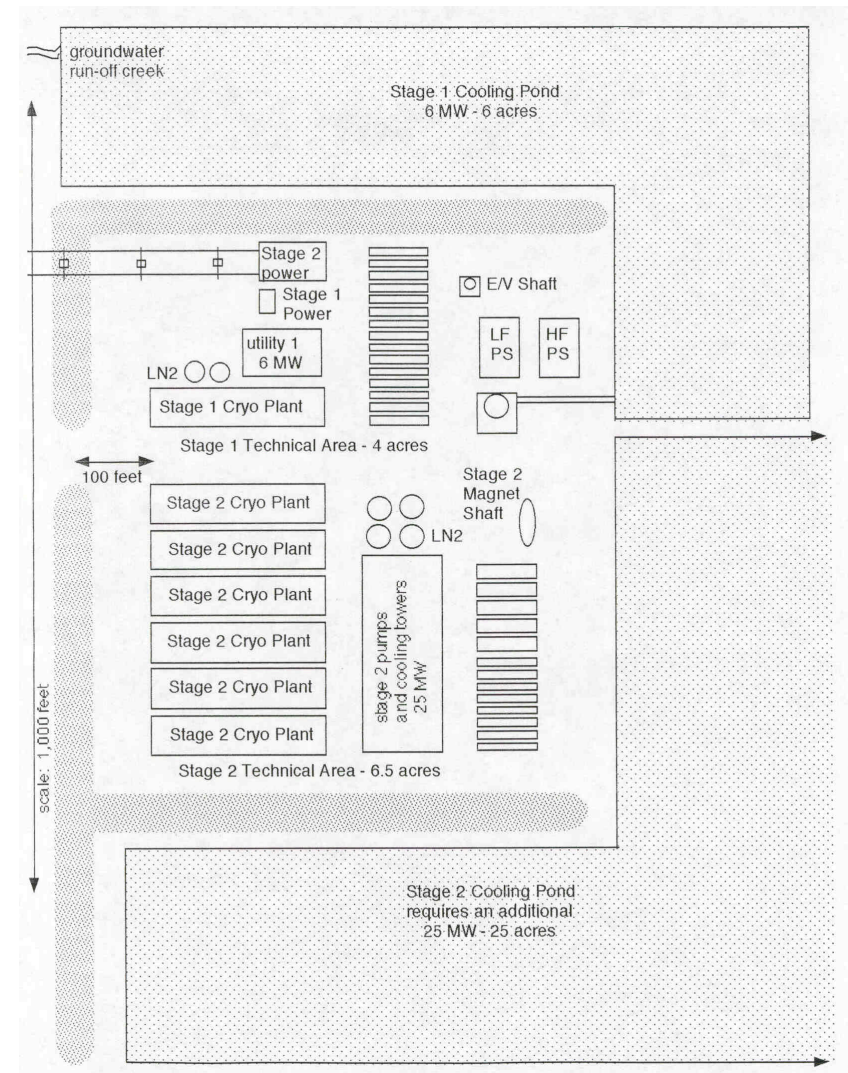
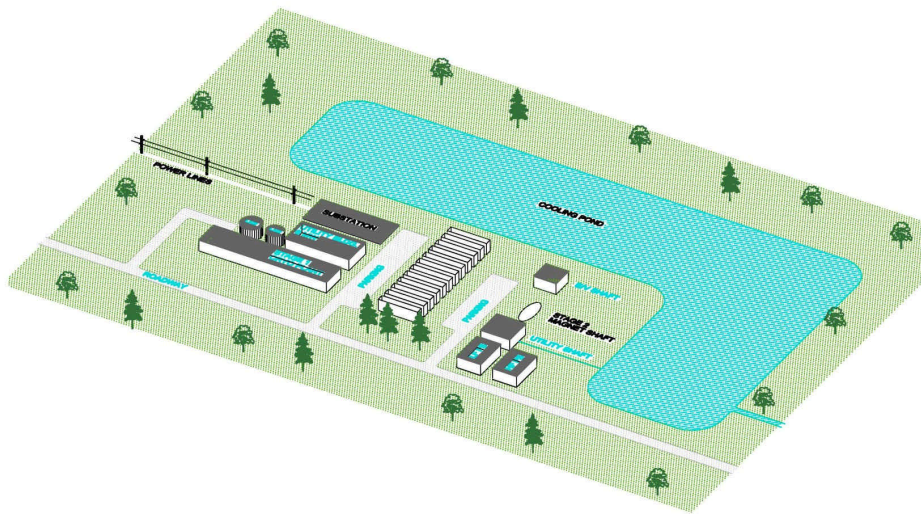
E/V sites



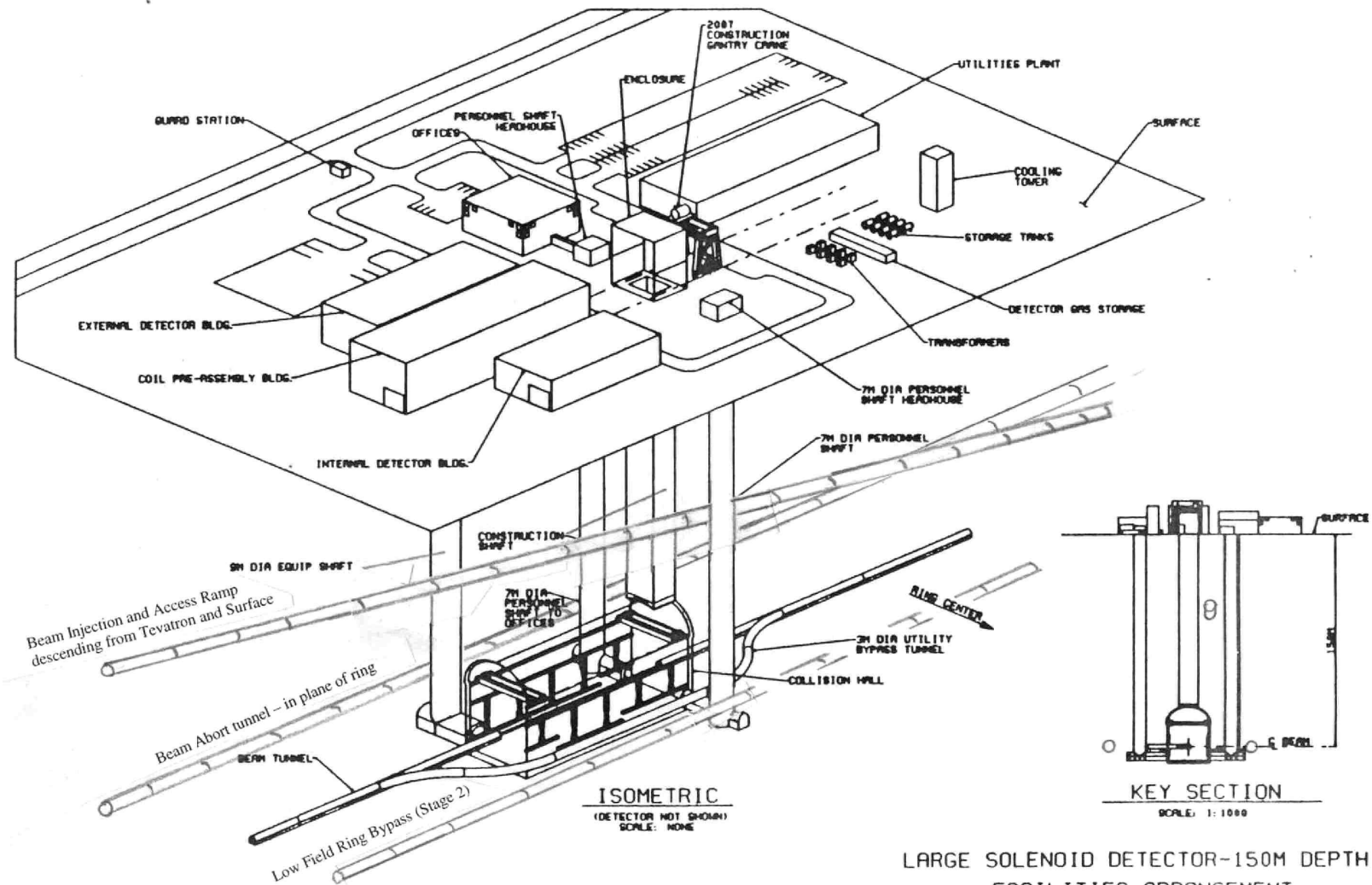
Utility Plants (on surface)

A-site (Stage 1 only)
approx. 10 acres

Stage 2 A-&B-sites
approx. 40 acres



Schematic of Experimental Area (generic SSC Large Solenoid Detector)



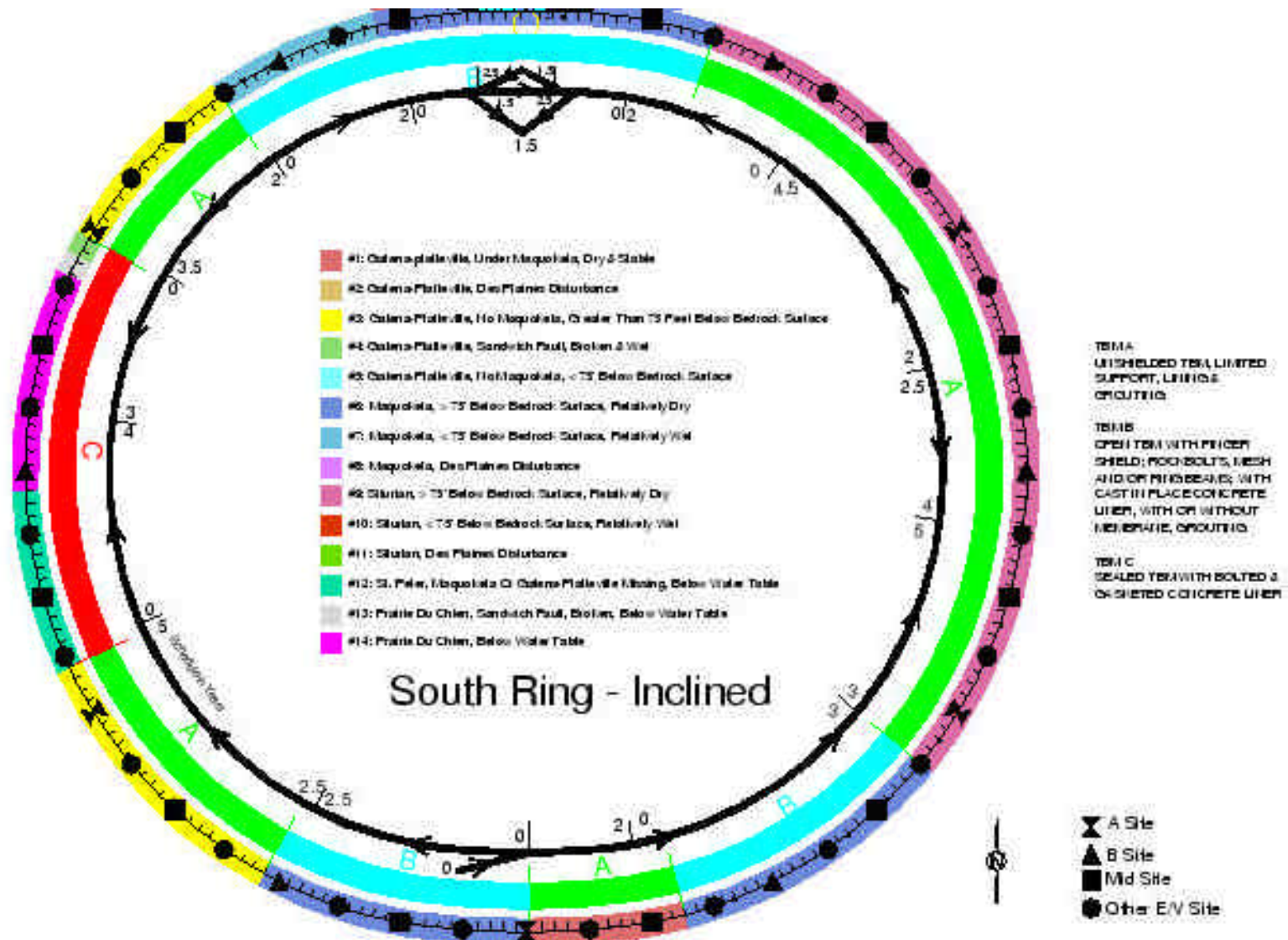
LARGE SOLENOID DETECTOR-150M DEPTH
FACILITIES ARRANGEMENT
ISOMETRIC AND KEY SECTION
01-M-01

Cost & Schedule Estimating

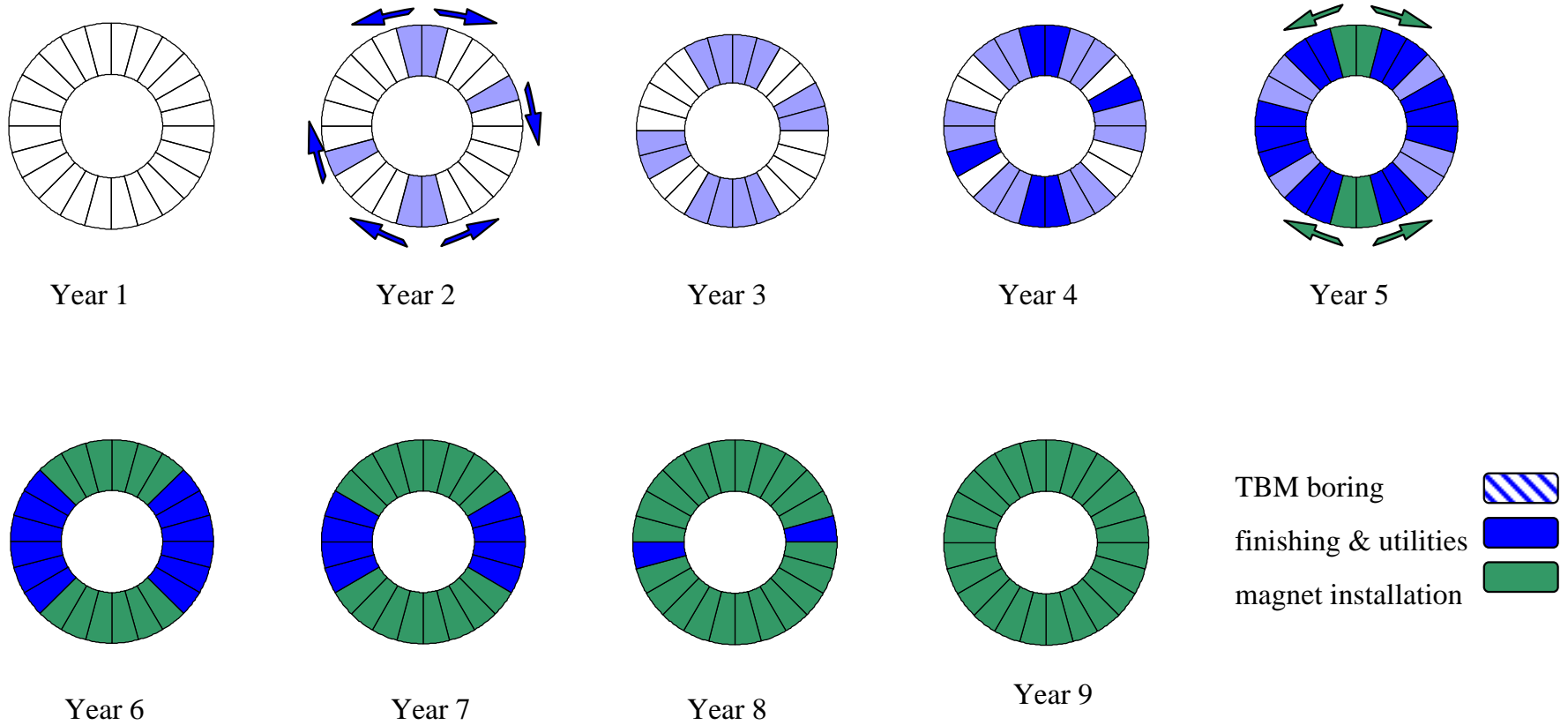
- Kenny Co. (1997) - 3 TeV VLHC Booster
- CNA Consulting Engineers, Minneapolis
- Hatch-Mott-MacDonald, Toronto
- 3 tunnel configurations, unit cost & blocks
- to understand sensitivities and trade-offs
- Inputs:
 - a. geology & siting - lampshades, contacts
 - b. components - tunnel, shafts, & caverns
 - c. unit costs - conditions, depths, contacts

- vary a. and/or b. \Rightarrow New Cost Estimate
- estimate does NOT include:
 - Land Acquisition or Easements (State)
 - Spoils Disposal (revenue neutral?)

most varied geologic model studied
complete tunnel construction in 5 years



VLHC-I Tunnel Construction and Magnet Installation Plan



CNA Underground Construction

Cost Estimate Summary, May 20, 2001

• Item \$ 1 M units	North	North	South
• 12 ft diameter	Inclined	Flat	Inclined
• Shafts	\$ 414 M	\$ 263 M	\$ 168 M
• Caverns (incl. 2 Exp)	\$ 232	\$ 238	\$ 243
• TBM Tunnels	\$ 866	\$ 1,058	\$ 1,166
• D&B Tunnels	\$ 36	\$ 36	\$ 36
• Alignment Risers	\$ 3	\$ 2	\$ 2
• Portals	\$ 2	\$ 2	\$ 2
• Misc. (5% non-est)	\$ 83	\$ 85	\$ 86
• Subtotal	\$ 1,636 M	\$ 1,685 M	\$ 1,703 M
• EDIA (17.5% external)	\$ 286	\$ 295	\$ 298
• Total	\$ 1,922 M	\$ 1,980 M	\$ 2,001 M

Underground Construction Cost Est.

- EDIA: (external) includes A&E and CM contractors & multiple site studies, does NOT include internal Lab EDIA
- CNA recommends 25-30 % contingency on underground construction, based on level of understanding specific geologic conditions
- ratio $16'/12' = 1.24$ (on TBM costs only)
- $= 1.16$ (total undergrnd costs)

Other Construction Costs

- Underground Utilities \$ 144 M
 - AC power, HVAC, Pumping, Elevators/Stairs
- Surface Buildings & Utilities \$ 310 M
- Experimental Areas (not estimated)
- Roads (not estimated)
- Power from Utility (not estimated)
- Ground Water Discharge (not estimated)

Special ES&H Issues for VLHC

- Generic ES&H Issues for New Accelerators
-J.D. Cossairt et al., FERMILAB-Conf-01/051-E
- Diameter of tunnel -12 feet? or larger?
 - access, egress, install, maintain \Leftrightarrow COST
- Emergency egress every 3 miles (SSC-2.7)
- Minimum fire & smoke hazard
- auto fire suppression for special caverns
- sufficient O₂ on vehicles (no refuges)

Special ES&H Issues continued:

- groundwater issues, aquifers, G-P aquitard
- much of tunnel below piezometric surface
- minimize water inflow, construction & ops
- quality of water discharge, pH & particulate
- prevent contamination (conv. & radiation)
- and de-watering of aquifer
- rad: well-free zone of approx. 100 ft. radius

Special ES&H Issues continued:

- heat rejection, mainly Stage 2 Cryo plants
- air-cooling towers or cooling ponds
- (1 acre per MWatt)
- optimal aesthetic/community choices
- spoils/muck disposal (commercial value?)
- impact on communities, especially during
- construction, return areas back in an
- environmentally acceptable condition

Engineering/Design Challenges

goal => reduce COST

- simplify underground construction
- initiate R&D on tunneling methodologies
- optimize strategy for TBM utilization
- is there enough space for full Stage 2
 - functionality, e.g. abort?
- optimize size for experiment caverns
 - engineering & physics optimize roof spans
 - optimize deep equipment installation shafts
 - different beam heights for Stage 1 and 2